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Optical and Electronic Characteristics of Germanium Quantum Dots Formed by Selective Oxidation of SiGe/Si-on-Insulator PEI-WEN LI, WEI-MING LIAO, MING-TING KUO, W.T. LAI, Dept. of E.E., National Central Univeristy — A complementary metal-oxide-semiconductor (CMOS)-compatible method is proposed to form atomic-scale germanium (Ge) quantum dots (<10 nm) for application in single-electron (SE) devices or optical devices. The formation of Ge quantum dots is realized by the Ge atoms' segregation and agglomeration during thermal oxidation of $Si_{1-x}Ge_x$ alloys. The size and distribution of the Ge dots are determined by conditions of thermal oxidation process and Ge content in the alloys. The optical and electronic characteristics of Ge quantum dots were examined by x-ray diffraction, high-resolution transmission electron microscopy, cathodoluminescence spectroscopy, and spectroscopic ellipsometry. The dot size and crystallite morphology were strongly dependent on thermal oxidation conditions. Visible photoemissions from Ge dots were observed at room temperature and they exhibited pronounced blueshifts of peak energies with increasing oxidation time, which can be correlated to the change in dot size, shape, or crystalline structure transition. Compared to bulk Ge, the reduced refractive index and relevant blueshifts of band-structure critical points of Ge quantum dots, derived from spectroscopic ellipsometry, are also correlated to the nanocrystal size effects.

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